Powdered Grape Juice[a]

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A process was developed on a pilot-plant scale for the preparation of powdered grape juice. Good flavor is obtained in the product by first recovering the aroma from the juice, then concentrating the juice under vacuum, adding sucrose to the extent of 50% of the grape solids, adding aroma on the basis of the total solids, and drying in a vacuum tray drier under conditions to favor the development of flavor. The product is ground and canned with an inpackaged desiccant to prevent lumping.

The current trend to fruit juice concentrates has led inevitably to study of the ultimate in such concentrates, i.e., fruit juice powders. The U. S. Department of Agriculture recently announced the successful preparation of powdered orange juice.[c] The present publication describes a powdered grape juice developed at the Bureau of Agricultural and Industrial Chemistry, Eastern Regional Research Laboratory, USDA, in which the flavor is fixed by a method differing from that found satisfactory for orange juice.

BACKGROUND CONSIDERATION

Mere drying of a fruit juice or juice concentrate to a powder has often been accomplished. If the product is to find public acceptance, however, it must store well and dissolve rapidly, and above all the resulting beverage must possess a good taste and aroma peculiar to the fruit. Attainment of this last attribute poses a problem because in removing the large amount of water necessary to convert a juice to a dry powder, the volatiles, which contribute largely to the characteristic fruit flavor, are ordinarily lost.

Since fruit juices consist largely of water, it would not be economical to convert them to powder by direct drying. A more economical method is to concentrate them in vacuum evaporators, and then to remove the remaining water by vacuum drying to avoid damage by heat. Such a procedure also enables recovery of the volatiles in essence form for later restoration to the product. Methods developed by this Bureau for recovering fruit essences have been published *(1, 2, 3, 4, 7, 8, 9, 10, 12)*. Restoration of essences to juice concentrates entails no difficulties, but since most essences are extremely dilute aqueous solutions of the volatile flavoring components, their addition to dry powder requires special techniques *(11)*.

From Concord grape juice we have produced a powder to which essence need not be restored. The essence is added instead to the concentrate before drying. This is done by recovering the essence from the juice by one of the methods developed by this Bureau, depectinizing the juice, concentrating it under vacuum to approximately 80° Brix, adding sucrose to the extent of about 50% of the grape solids, adding the essence to the concentrate in proportion to the total solids, and then drying the concentrate in a vacuum tray drier, under conditions conducive to the development of flavor. If the sucrose is not used in the procedure just mentioned, the product will be unsatisfactory. It will possess a scorched molasses-like character, and it will lack the characteristic aroma of grape juice. Sucrose not only tends to prevent the development of off-flavors but it aids in the retention of the essence.

The mechanism by which sucrose functions to cause these results is not clearly understood. Sucrose does not participate in the Maillard reaction, and its presence to the extent of 50% of the grape solids would be expected to retard significantly the development of off-flavors, by mere dilution of the reacting ingredients. Its role in retarding off-flavors during drying of the concentrate appears analogous to its ability to prolong greatly the shelf life of grape concentrates at elevated temperature.[d]

In the absence of added sucrose the restored volatiles escape quickly, and hence contribute nothing to the flavor of the product. With sufficient sucrose, the volatiles are apparently retained during drying, at least sufficiently long to react with nonvolatile constituents, thereby enhancing the flavor. This enhancement of the flavor by aging or maturing in the presence of the volatiles has been shown also to take place[d] when grape juice concentrates containing essence were stored for long periods at 35° F. (1.7° C.). When the juice concentrate and essence were stored separately and combined at the time of tasting, the flavor was inferior to that of concentrate stored with its essence.

Although powdered juices represent the ultimate in concentration, they are bulkier than high-density juice concentrates. Therefore, to represent an advance over concentrates, powders must possess some superior attribute. In general this attribute is presumed to be better keeping properties at elevated temperature because of the extremely low water content. The storage properties of the powdered grape juice discussed here are being determined with and without vacuum packing, by tests at room temperature and at 100° F. (37.8° C.). Pending final results of storage, this process is not recommended for commercial use.

EXPERIMENTAL

Preparation of the full-flavor concentrate. The full-flavor grape juice concentrate to be dried was prepared by the method described in *AIC-342 (3)*, except that for better flavor, essence was added in proportion to the total solids rather than in proportion to the grape solids only. Since the concentrate was to be made into a powder, vacuum concentration of the juice was carried even further than the 74.9° Brix recommended in *AIC-342*. Concentrates of 85° Brix or higher may be made without heat damage if rapid evaporation is carried out at high vacuum. A sucrose solution of the same Brix as the concentrate was then added in a quantity corresponding to about 50 parts of sucrose per 100 parts of grape solids. The amount to be added is governed somewhat by the acidity of the juice. Use of much less than this proportion, however, may impair the retention of essence during drying. A fruit acid such as tartaric may be added if required to give a palatable *sugar: acid* ratio. After essence was added in proportion to the total solids present, the concentrate was ready for drying.

Drying. The following method of drying full-flavor grape juice concentrate containing sucrose was designed to produce a product with good flavor and a moisture content below about 2% to enable grinding. The operation was carried out in a vacuum shelf drier of conventional design, equipped with platens supplied with water controllable to any desired temperature from tap temperature to 200° F. (93° C.). The vacuum system was capable of reducing the pressure in the empty drying chamber to less than 0.25 inch (6.35 mm.) of mercury.

A typical pilot-plant drying run proceeds as follows: The concentrate is charged to the pan with a loading of 0.9 pound of 80° Brix concentrate per sq. ft. of pan bottom area. Water at 190° F. (88° C.) is circulated through the platens. The pans

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[b] One of the Laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Service, U. S. Department of Agriculture.

[c] USDA Press Release, "New Orange Powder Developed by USDA Stores Well, Makes Excellent Beverage," issued January 12, 1953.

[d] Unpublished records of Eastern Regional Research Laboratory.

are placed in the drier, the door is closed, the vacuum applied. Before bubbling begins, the concentrate will reach a temperature of 145-155° F. (63-68° C.) When the vacuum reaches 3.5-4.5 inches (89-114 mm.) of mercury absolute, sudden flashing commences, causing a rapid falling of the temperature of the concentrate and vigorous foaming, which rises to a depth of 2 inches or more. This can be considered as the boiling stage preceding drying proper. In about 4 minutes the foaming subsides and the concentrate temperature begins rising from a low of 120-130° F. (49-54° C.). At this point, drying proper may be considered to begin. Experience has shown that the best flavor is obtained by maintaining the concentrate temperature at 160° F. (71° C.) for approximately the last 1½ hours of the drying cycle.

The concentrate temperature was controlled by adjusting the temperature of the platen water. Figure 1 shows the relationship between the temperature of the concentrate and that of the platen water.

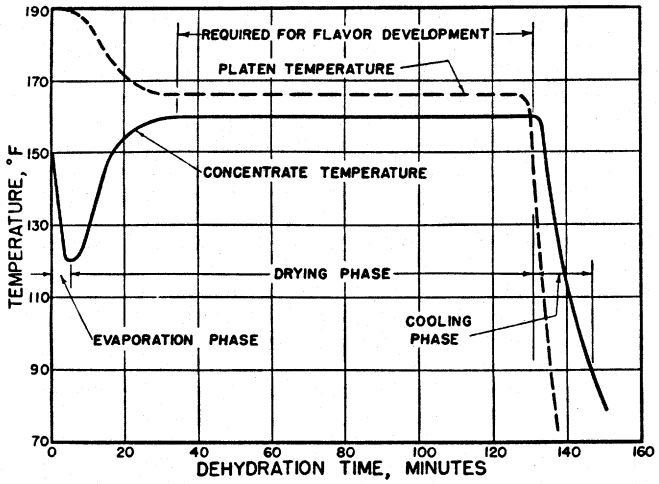

Figure 1. Concentrate and platen temperatures during drying of grape juice concentrate.

In order that the dried product will have the desired moisture of between 1.5 and 2.25% and with the time and temperature fixed by flavor considerations as described above, the vacuum during the last 1½ hours must be kept approximately between about 0.35 and 0.45 inch (9-11 mm.) of mercury absolute.

At the completion of drying the product will still show some evidence of bubbling and will be in a molten state. It must, therefore, be cooled before removal from the drier. It is sufficiently brittle at 90° F. (32° C.). The time to cool to a brittle state is dependent on the temperature of the cooling water. Cooling is done under vacuum to prevent rehydration. The total cycle in the drier need not exceed about 2½ hours. This corresponds to a drying capacity of about 0.3 pound of product per hour per sq. ft. of pan bottom.

Some difficulty was encountered in removing the glass-like material from the pans unless precautions had been taken to minimize sticking. The material adhered tenaciously to an uncoated No. 4 stainless steel surface and also to enameled surfaces. Various coating materials were tried on stainless steel, with only moderate success. The best results so far were obtained by coating a stainless steel pan with Johnson's Corrosion Inhibitor Wax.* When a pan so coated was used, the product could be removed by a brisk tap on the bottom of the inverted pan—applied with insufficient force to dent or permanently distort the pan. The product could be easily removed if the pan was first lined with aluminum foil.

Grinding. At the completion of drying, the product is glass-like, and after cooling in the drier as described above, can be ground to a granular powder without caking. All operations subsequent to drying, i.e., removal from the pans, further cooling, grinding, and packaging, must be done in a low-humidity room because of the hygroscopicity of the product. The product described above was satisfactorily handled at 70° F. (21° C.) and a relative humidity below 15%. The product was so ground as to have coarse granular structure with no particles retained on a 10-mesh screen (0.065-inch opening) (1.65 mm.). Fine grinding causes gummy lumps when the product is reconstituted.

Packaging. To keep the moisture content extremely low, thus preventing caking during storage and prolonging shelf life, the product was hermetically sealed in cans with an envelope containing a desiccant *(5, 6, 11)*. The weight of the desiccant was appoximately one-tenth the weight of the powder. The bulk density of the grape juice powder is about 56 pounds/cubic foot (0.90 g./cc.). A 4-ounce can holds the packaged desiccant and about 3.4 ounces (97 g.) of the powder.

Reconstitution. To obtain a beverage of approximately 14.5° Brix, the contents of the can should be dissolved in 4 cans of cold water.

Storage Properties

One of the incentives for converting a fruit juice concentrate to powder is to obtain superior keeping properties at elevated temperature. Although storage tests are not yet completed on powdered grape juice it is already apparent that its storage properties at 73° F. are excellent. After 6 months at this temperature a trained taste panel could detect only a very slight change in flavor. At the same rate of flavor change the product would be well above the acceptable limit after one year at room temperature.

CONCLUSION

The reconstituted juice has the characteristic appearance of Concord grape juice. It has a strong grape flavor of pleasing character but somewhat different from that of bottled grape juice.

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* Mention of products in this paper does not imply recommendation or endorsement by the United States Department of Agriculture over other products not mentioned.